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WINTER TEMPERATURE PROFILES IN PIG BUILDINGS INCORPORATING MODIFIED AUTOMATICALLY CONTROLLED NATURAL VENTILATION

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INTRODUCTION

Stable temperatures with consistent distributions are components of an effective ventilation system in pig housing. Previous studies of automatically controlled natural ventilation (ACNV) during winter and summer months have shown that adequate overall temperature control can be achieved in houses which incorporate cross flow ventilation with a single control system (Barrie, Smith and Yeo, 1985). Derivatives of this basic design are sometimes used in attempts to cope with anticipated or actual problems in pig housing. Two of these were studied which involved: (1) separate temperature control of three zones within a single building; and (2) the incorporation of a continuous, narrow ridge outlet in a cross flow system.

THE BUILDINGS AND SITING

Three-zone dry sow and service stall house (Figure 1)

This house, measuring 49 × 13 m had a particularly poor exposure being sheltered on three sides with one end exposed to the east. Three independent zones of control were incorporated into the building from new to overcome expected temperature control problems arising from both the poor aspect and uneven heat output caused by the low stocking density in the service area.

Partitioned finishing house with ridge outlet (Figure 2)

This house (37 × 12 m) was set on a bank above other farm buildings and well exposed to winds from all directions. Being orientated north to south the building was particularly exposed to winds from the east or west. Following problems created by unsatisfactory pig dunging in summer, a ridge outlet, 136 mm wide, was constructed along half of the building. There was a solid partition separating the two halves, each of which had its own ventilation controllers.

ENVIRONMENTAL RECORDINGS

Ten-minute temperature recordings were automatically logged at eight locations in both buildings. The sow house was studied between 17 and 29 January and the finishing house between 12 and 25 February and 5 and 10 March 1986. Ambient temperatures were recorded with sensors exposed in a saucer screen sited about 100 m from the nearest buildings. Hourly wind data were taken from the Meteorological Office at Birmingham Airport which is 30 km to the south-east of the stall house and 40 km north-east of the finishing house. Daily mean temperatures in January (17 to 23) were close to the monthly normal of 3°C but fell to between 1·5°C and −1·5°C between 24 and 29 January. Winds were generally south-westerly but periods of south, west and north-westerly winds occurred during the study. Daily mean wind speeds, recorded at 10 m above ground, were variable ranging from 2·0 to 8·0 m/s during the study period.

February was dominated by moderate north-easterly winds, reaching 9 to 10 m/s at times while temperatures remained sub-zero. At best, ambient temperatures rose to 2°C by day but frequently remained below freezing and falling as low as −6 to −10°C by night.

Between 5 and 18 March temperatures were close to normal (5°C) and the winds mostly south-easterly to south-westerly with daily mean speeds between 1·4 and 4·3 m/s.

VENTILATION DESIGN

Both buildings were designed to be ventilated by cross flow ACNV with virtually continuous openings along each side wall, just below the eaves. The ventilation flaps were centre pivoted and adjusted by controllers operating through a series of linear actuators. Neither of the buildings had end wall ventilation openings incorporated in the design.

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RESULTS

Dry sow and service stall house

Despite large variations in ambient temperature, wind speed and direction (although no extended calm periods occurred) the stall house produced near optimum temperature control. The range in 24-h mean internal temperatures between the warmest and coolest areas was normally less than 1°C (see Figure 3). The largest range (2·2°C) was recorded on 29 January and was most probably associated with the movement of boars from the service area at the west end of the building. Stock movements elsewhere were mostly confined to the eastern end where many stalls were empty for most of the study period. This produced no obvious effect on temperature. Greater detail of this study is given by Barrie (1986).

Partitioned finishing house

Considerably larger ranges in temperature were found in both sections of the finishing house. Due to its orientation, the building was particularly affected by the long spell of north-easterly winds. An analysis of the 24-h mean temperatures showed the daily range between the warmest and coolest areas was, on average, lower in the section incorporating the ridge outlet (Table 1).

The 3 to 5°C temperature ranges were broadly similar to those found in a much larger cross-flow finishing house (Barrie and Smith, 1986). A strong dependence of temperature change of 1 to 3°C across the partition will varying from 3 to 4°C during wind speeds below 2·5 m/s, 4 to 6°C while the wind speed was between 2·5 and 5 m/s, up to 6 to 7·5°C with wind speeds between 5 and 9 m/s. This was very similar to the relationship defined by Barrie and Smith (1986). Similarly, the strong influence of wind direction on the horizontal distribution of internal temperatures was confirmed (Figure 4). The temperature change of 1° to 3°C across the partition will be a common feature and may explain the perception of a 'fresher' environment as one crosses between sections. Draeger tube samples of carbon dioxide, ammonia and hydrogen sulphide showed very low levels of each, and no differences between sections.

TABLE 1

Finishing house mean daily temperatures ranges °C

Period	With ridge outlet: Mean	s.d.	Maximum	Minimum
12 to 25 Feb	3·3	1·3	5·6	1·6
5 to 18 March	4·0	1·4	6·0	1·2

Period	Without ridge outlet: Mean	s.d.	Maximum	Minimum
12 to 25 Feb	5·2	2·1	7·6	1·6
5 to 18 March	4·7	1·6	7·0	1·6

DISCUSSION

The stall house produced near optimum temperature control, despite variations in stocking density and during cold as well as average winter weather. The differential ventilation flap openings in the three control zones was visually apparent on each visit, but there was no visual evidence of hunting between sections where one controller may be unduly influenced by the status of an adjoining section.

The partitioned finishing house produced horizontal temperature distributions which were strongly influenced by wind speed and direction, thus corroborating an early, similar study by Barrie and Smith (1986). The section containing the ridge outlet produced rather smaller ranges in daily mean temperature, which is assumed to have been due to the building construction and not to a subtle difference in exposure. This improvement is likely to be due to the fact that a significant proportion of the ventilation exchange occurred through the (uncontrolled) ridge opening in winter months, thus reducing the volume of cold ambient air entering through the side wall openings. A rather more uniform and more evenly mixed environment results, probably in the vertical as well as the horizontal plane. The magnitude of the temperature range is apparently not a function of the floor area (Barrie and Smith, 1986). Accepting this, and given the frequent presence of adjacent cold and warm areas across the partition, it is clear that the partition is increasing rather than decreasing the temperature variations. Since the house is managed as if it were a single unit the partition serves no useful purpose and could be removed, thus modifying the system towards the principle of zonal control.

A similar study of this house in warm conditions (August 1985, unpublished data) failed to show any major differences between open and closed ridge halves of the building. Despite this, the reaction of the operator was that the open ridge section felt fresher.

Large enterprises sometimes seek to design finishing houses to be managed on an all in-all out basis, necessitating subdivision of buildings into a series of rooms. Our results show that unventilated end and intermediate walls tend to increase the temperature variation by creating warm zones on the lee sides of the walls. Modest ridge openings apparently reduce this effect.

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Fig. 1. Stall house

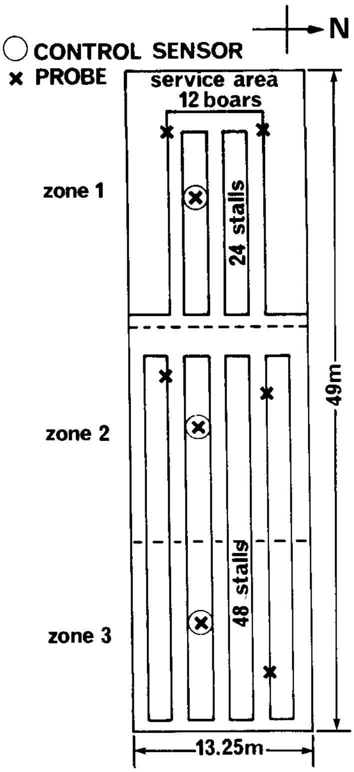

Fig. 2. Finishing house

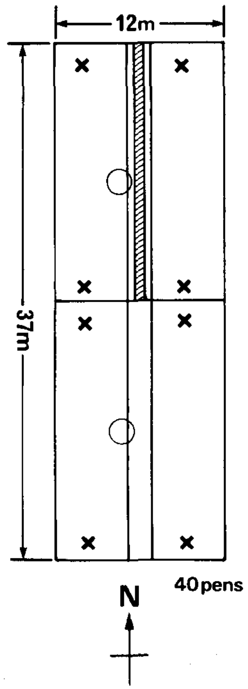

Fig. 3. Stall house
23/1/86

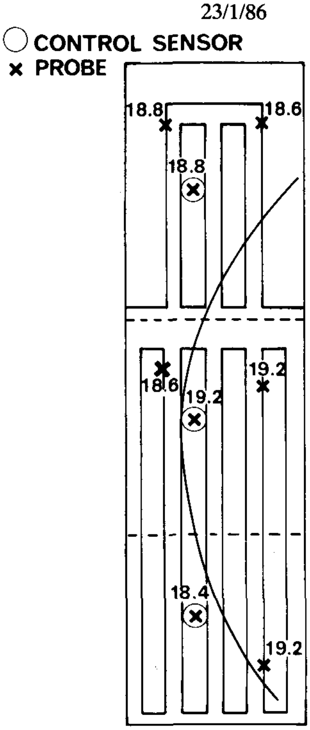

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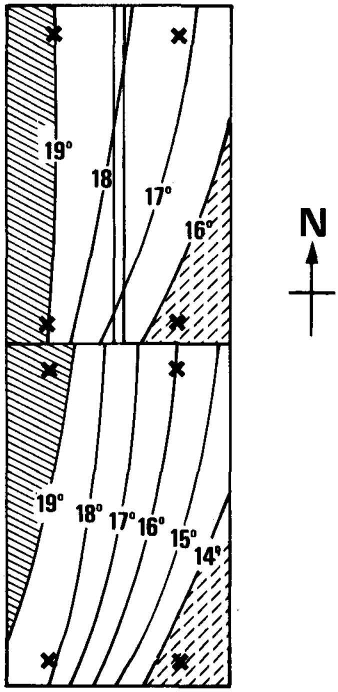
FIG. 4a. Finishing house

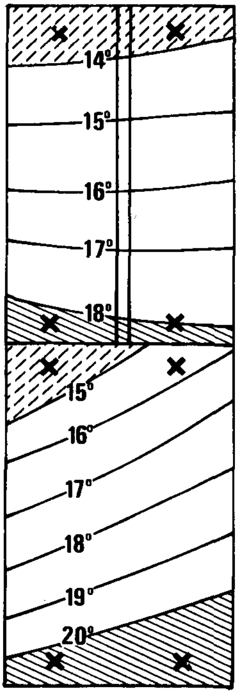
12.2.86



wind direction ESE
mean speed 4·8 m/s
mean temperature −2·2°C
stat 20°C

FIG. 4b. Finishing house

6.3.86



wind direction SW
mean speed 3·0 m/s
mean temperature 3·9°C
stat 15°C

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